6. Signal-Dependent Noise

Signal-Dependent Noise

Claim Term	CMU's Construction	Marvell's Construction
signal-dependent noise '839 Patent Claims 2 and 5 '180 Patent Claim 1	media noise in the readback signal whose noise structure is attributable to a specific sequence of symbols (e.g., written symbols). CMU Brf. at 32	noise that is dependent on the signal. Marvell Brf. at 34-35

- Dispute:
  - Does "signal-dependent noise" have its ordinary meaning (Marvell) or should it be limited to a particular type of noise (media noise) found in magnetic recording (CMU)?

No Further Construction Necessary

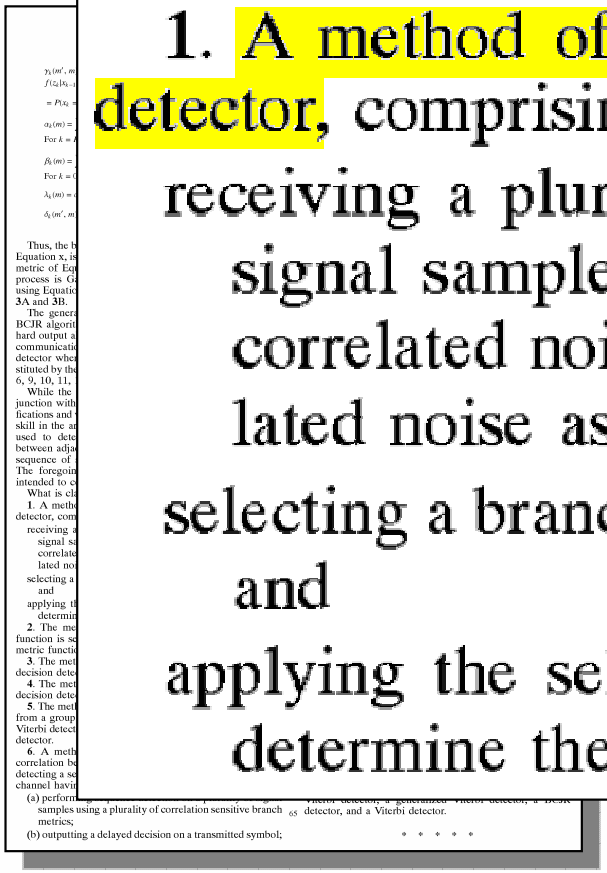
- Where "the ordinary meaning of claim language as understood by a person of skill in the art may be readily apparent even to lay judges, [ ] claim construction in such cases involves little more than the application of the widely accepted meaning of commonly understood words."

  Phillips, 415 F.3d at 1314.

  - Jury will be instructed on agreed-to meanings:
    - "signal sample" means "a value of a signal at a certain point in time."
    - "noise" means "an unwanted disturbance in a signal."
  - "dependent" is well-known — Joint Agreed Terms (Dkt. 74)
  - "Signal Dependent Noise" thus means "noise that is dependent on the signal"

CMU's "Media Noise" Argument Fails

- Claimed method refers to generic noise types
- Claimed method not limited to magnetic recording



1. A method of determining branch metric values in a detector, comprising:

receiving a plurality of time variant signal samples, the signal samples having one of signal-dependent noise, correlated noise, and both signal dependent and correlated noise associated therewith;

selecting a branch metric function at a certain time index; and

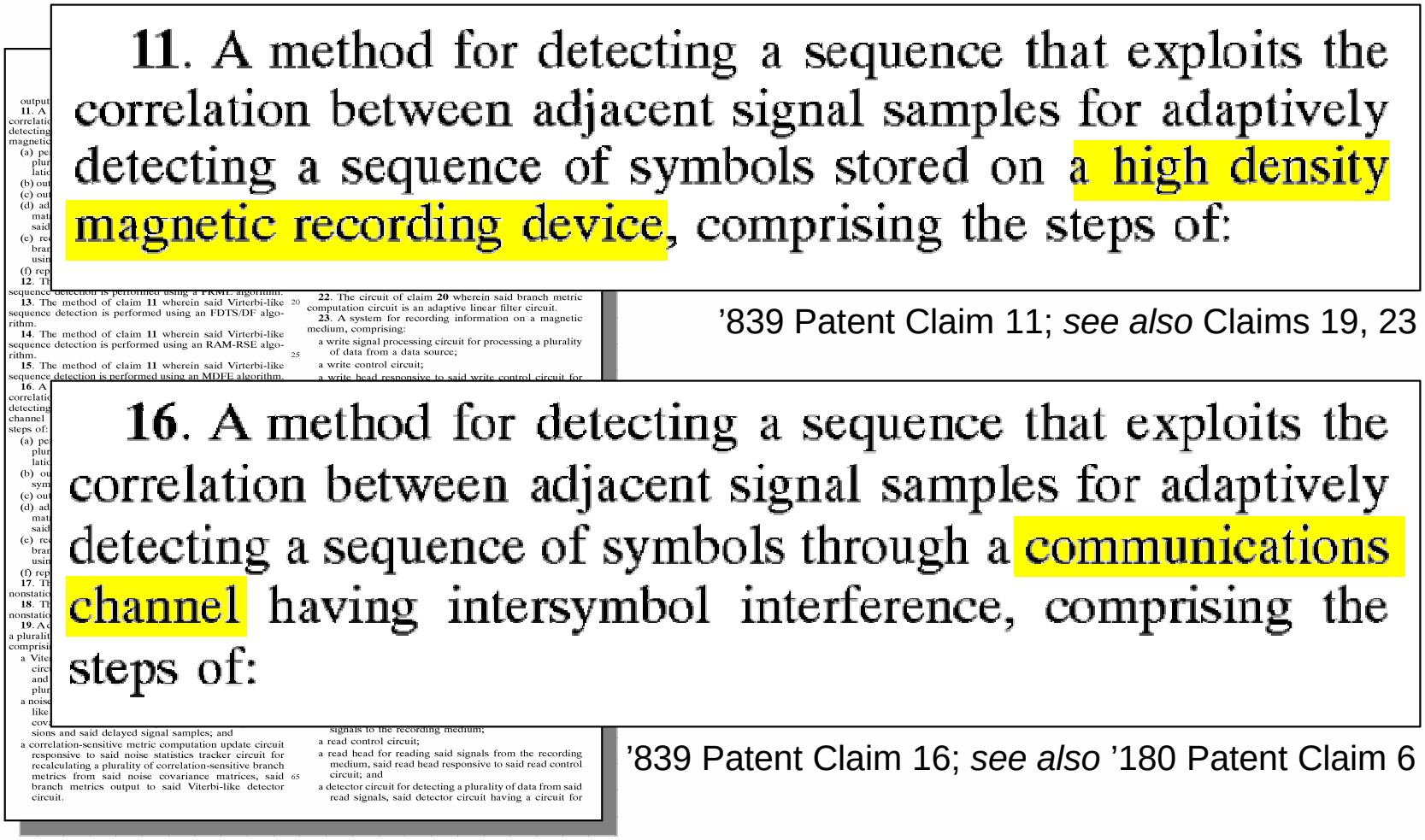
applying the selected function to the signal samples to determine the metric values.

'180 Patent Claim 1

See also '839 Patent Claims 2,5

CMU's "Media Noise" Argument Fails

- Other Asserted Claims cover communications channels in addition to magnetic recording



11. A method for detecting a sequence that exploits the correlation between adjacent signal samples for adaptively detecting a sequence of symbols stored on a high density magnetic recording device, comprising the steps of:

'839 Patent Claim 11; *see also* Claims 19, 23

16. A method for detecting a sequence that exploits the correlation between adjacent signal samples for adaptively detecting a sequence of symbols through a communications channel having intersymbol interference, comprising the steps of:

'839 Patent Claim 16; *see also* '180 Patent Claim 6

CMU's "Media Noise" Argument Fails

- Specification relates "media noise" to recording

> Due to the signal dependent nature of media noise in magnetic recording, the functional form of joint conditional pdf f $(r_1, \ldots, r_N | a_1, \ldots, a_N)$ in (1) is different for different symbol sequences $a_1, \ldots, a_N$. Rather than making this

'839 Patent 4:24-26

- Confirms scope of patents beyond recording

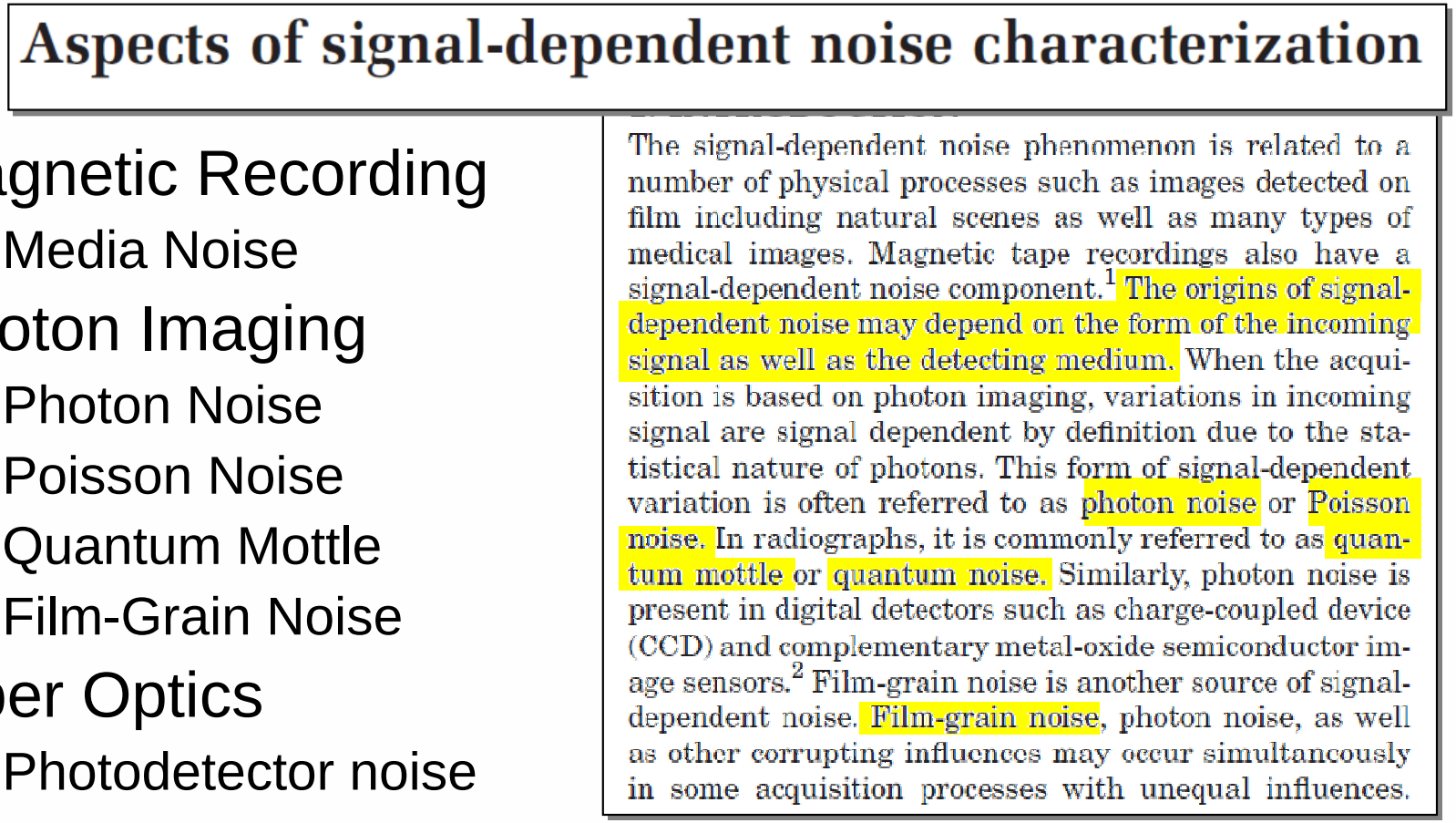
> While the present invention has been described in conjunction with preferred embodiments thereof, many modifications and variations will be apparent to those of ordinary skill in the art. For example, the present invention may be used to detect a sequence that exploits the correlation between adjacent signal samples for adaptively detecting a sequence of symbols through a communications channel. The foregoing description and the following claims are intended to cover all such modifications and variations.

'839 Patent 13:51-59

Background: Other Signal Dependent Noise Sources

- Media Noise is not the only source of signal-dependent noise in other channels

  - Magnetic Recording
    - Media Noise
  - Photon Imaging
    - Photon Noise
    - Poisson Noise
    - Quantum Mottle
    - Film-Grain Noise
  - Fiber Optics
    - Photodetector noise



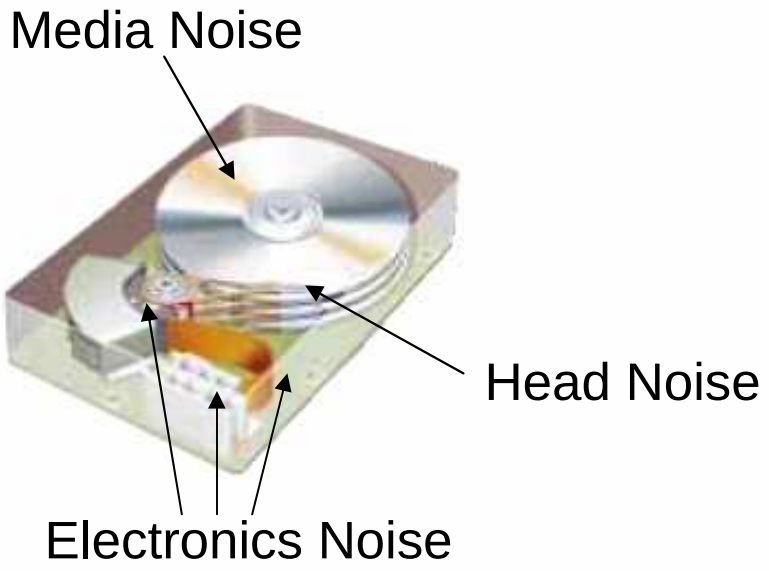
Aspects of signal-dependent noise characterization

The signal-dependent noise phenomenon is related to a number of physical processes such as images detected on film including natural scenes as well as many types of medical images. Magnetic tape recordings also have a signal-dependent noise component.[1] The origins of signal-dependent noise may depend on the form of the incoming signal as well as the detecting medium. When the acquisition is based on photon imaging, variations in incoming signal are signal dependent by definition due to the statistical nature of photons. This form of signal-dependent variation is often referred to as photon noise or Poisson noise. In radiographs, it is commonly referred to as quantum mottle or quantum noise. Similarly, photon noise is present in digital detectors such as charge-coupled device (CCD) and complementary metal-oxide semiconductor image sensors.[2] Film-grain noise is another source of signal-dependent noise. Film-grain noise, photon noise, as well as other corrupting influences may occur simultaneously in some acquisition processes with unequal influences.

Heine and Behera, *Aspects of signal-dependent noise characterization*, J. Opt. Soc. Am. A/Vo.23, No.4 806 (April 2006) (Proakis Supp. Exh. 1); *see also* Xi and Adal, *Integrated MAP Equalization and Turbo Product Coding for Optical Fiber Communications Systems*, IEEE Globecom (2005) (Proakis Supp. Exh. 2). *See* Supp. Proakis Decl. at ¶¶ 7-8.

Background: Sources of Noise

- Media Noise
  - media nonlinearities
  - signal nonlinearities
  - inter-symbol interference
  - off-track interference
- Electronics Noise:
  - front-end equalizers
  - thermal noise
  - amplifier noise
- Head Noise:
  - head nonlinearities
  - head impedance



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